JUN 2 1917
UNIV. OF MICH. LIBRARY

SCIENCE

NEW SERIES
VOL. XLV. No. 1170

FRIDAY, JUNE 1, 1917

SINGLE COPIES, 15 CTS.
ANNUAL SUBSCRIPTION, $5.00

BOOKS

Prentiss' Embryology

Laboratory Manual and Text-Book of Embryology. By CHARLES W. PRENTISS, Ph.D., formerly Professor of Microscopic Anatomy in the Northwestern University. Octavo of 400 pages, with 400 illustrations. $3.75 net.

Howell's Physiology

Physiology. By WILLIAM H. HOWELL, Ph.D., M.D., Professor of Physiology in the Johns Hopkins University. Octavo of 1020 pages, 306 illustrations. $4.00 net. *New (6th) Edition.*

Stiles' Physiology

Human Physiology. By PERCY GOLDTHWAIT STILES, Assistant Professor of Physiology at Harvard University. 12mo of 405 pages, illustrated. $1.50 net.

Stiles' Nutritional Physiology

Nutritional Physiology. By PERCY GOLDTHWAIT STILES, Assistant Professor of Physiology at Harvard University. 12mo of 288 pages, illustrated. *Second Edition.* $1.25 net.

Stiles on the Nervous System

Nervous System and Its Conservation. By PERCY GOLDTHWAIT STILES, Assistant Professor of Physiology at Harvard University. 12mo of 275 pages, illustrated. $1.25 net.

Hill's Normal Histology

Normal Histology and Organography. By CHARLES HILL, M.D., formerly Assistant Professor of Histology and Embryology, Northwestern University. 12mo of 483 pages, 337 illustrations. *Third Edition.* $2.25 net.

Jordan's Bacteriology

General Bacteriology. By EDWIN O. JORDAN, Ph.D., Professor of Bacteriology in the University of Chicago. Octavo of 650 pages, illustrated. *New (5th) Edition.* $3.25 net.

Herrick's Neurology

Introduction to Neurology. By C. JUDSON HERRICK, Ph.D., Professor of Neurology in the University of Chicago. 12mo of 360 pages, illustrated. $1.75 net.

Fred's Soil Bacteriology

Soil Bacteriology. By E. B. FRED, Ph.D., Associate Professor of Agricultural Bacteriology, College of Agriculture, University of Wisconsin. 12mo of 170 pages, illustrated. $1.25 net.

Lusk's Nutrition

Elements of Nutrition. By GRAHAM LUSK, Ph.D., Professor of Physiology at Cornell Medical School. Octavo of 500 pages. *New (3rd) Edition.—Ready Soon.*

W. B. SAUNDERS COMPANY Philadelphia and London

THE PRINCIPLES OF STRATIGRAPHY

BY

AMADEUS W. GRABAU, S.M., S.D.

PROFESSOR OF PALEONTOLOGY IN COLUMBIA UNIVERSITY

"Should be on the reference shelf of every college, normal school, and large high school in the United States."—*Journal of Geography*, Vol. XIII, Jan. 1915.

8vo, 1150 pages, 264 illustrations. Price, $7.50

Descriptive Circular Sent upon Request

A. G. SEILER & CO.

NEW YORK CITY

Country Life Education Series

Garden Farming

By LEE CLEVELAND CORBETT, Horticulturist in the Bureau of Plant Industry, United States Department of Agriculture.

8vo, cloth, 462 pages, illustrated, $2.00

First-hand information on American methods of cultivating, harvesting, and marketing vegetables—both under glass and in the field.

Among the Subjects Discussed:

The Soil as a Factor in the Work of the Market Gardener.
Commercial Production of Plants for Transplanting Purposes.
Forcing and Forcing Structures.
Root Cellars and Storage Houses.
Problems of Transportation.
Precooling.
Economy of the Home Garden.
Vegetables—their Development, Cultivation and Uses.

Ginn and Company

Boston
New York
Chicago
London

Atlanta
Dallas
Columbus
San Francisco

A New Scientific Series

HARVARD AFRICAN STUDIES

O. BATES, M.A., F.R.G.S., Editor

F. H. STERNS, Ph.D., Assistant Editor

The African Department of the Peabody Museum of Harvard University announces a new scientific series devoted to the study of the African archaeology and anthropology in the widest sense, and to the scientific phases of the negro problem in America. The series will consist of annual volumes of short papers, and occasional monographs.

The editors will welcome contributions giving the result of original studies within the scope of the series. Although planned to afford a medium of publication for African studies in America, and to encourage such researches, the volumes are open to all investigators.

Now Ready, Volume I

VARIA AFRICANA I

xiv+292 pp., 8 x 10 1-2 ins., 30 heliotype pls., 30 photolith pls., figs. in text.
Cloth, $10.00, post free.

Includes papers on African folk-lore, ancient Egyptian surgery, the paleolithic period, the Canary Islands, Benin, Darfur, ancient Egyptian fishing, etc., with a bibliography of Africana for 1915.

Copies may by obtained from the ASSISTANT EDITOR, H. A. S., Dept. C, Peabody Museum, Cambridge, Massachusetts

SCIENCE

FRIDAY, JUNE 1, 1917

CONTENTS

The Function of Mathematics in Scientific Research: PROFESSOR G. A. MILLER 549

Scientific Events:—

Forestry Organization for the War; Expeditions of the Smithsonian Institution; Appropriations of the General Education Board; The Ramsay Memorial Fund 558

Scientific Notes and News 560

University and Educational News 563

Discussion and Correspondence:—

A Topographic Map of Wisconsin: PROFESSOR W. M. DAVIS AND PROFESSOR LAWRENCE MARTIN. *Winter Activity of the Brown Bat:* ROBERT CUSHMAN MURPHY. *Dr. Hobbs on the History of Science:* THOMAS F. WOODLOCK 564

Scientific Books:—

De Fursac and Rosanoff's Manual of Psychiatry: PROFESSOR ADOLF MEYER 566

Special Articles:—

A Suggestion regarding the Mechanism of One-sided Permeability in Living Tissues: PROFESSOR T. BRAILSFORD ROBERTSON 567

The Utah Academy of Sciences: A. O. GARRETT. 570

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FUNCTION OF MATHEMATICS IN SCIENTIFIC RESEARCH[1]

MATHEMATICS embodies some of the earliest scientific developments and hence she was practically unrestricted in regard to the selection of her location in what became later the domain of science. Did she select for herself the most fertile available land or was she misled by superficial attractions in making her choice, while the richest mines were hidden under other land whose surface presented fewer attractions and whose development demanded more complicated machinery? One might naturally expect different answers to this question from the members representing the varied interests of this Science Club.

It is not our purpose to extol the advantages of location with respect to the mathematical mine. This location was pointed out to you in your youth and the impressions which it has left on your minds are too deep to be modified materially by a few general remarks. Moreover, some of the tunnels of the mathematical mine are used daily by many of you, who gladly speed through them for the purpose of saving time to employ your energies more effectively in the field of your own choice.

Notwithstanding these facts, all will agree that the mathematical mine has been developed extensively, and that its developments have been most helpful and are becoming more useful to various other sciences. As the rivers excavated unknowingly for possible railroad lines through the mountains

[1] Read before the Science Club of the University of Wisconsin, April 5, 1917.

long before the construction of such lines was undertaken, so mathematics has been preparing thought roads for sciences long before their development was seriously begun. Hence it does not appear inappropriate for a body of scientists to pause now and then for a few moments to reflect on the methods and ideals which have actuated the mathematical investigator. Such reflections may be inspired by a sense of respect for all that contributes to scientific progress, but they should also prove helpful in the formation of most comprehensive notions in regard to the great problems which confront us as a united band of workers to secure light, to dispel more of the superstitions and to present far-reaching thoughts in the simplest manner.

Among the questions which scientists as a body might be inclined to ask the mathematician is the following: What is the attitude of mind which has contributed most powerfully to mathematical progress? Such a profound question would naturally be answered somewhat differently by different men, and your speaker to-night is not so completely ignorant of his own limitations as to suppose that he can furnish a final answer to this question. He hopes, however, that he may not be entirely unsuccessful in making some illuminating remarks on it, and in interesting you by directing your attention to common thoughts which underlie the varied efforts by which we as a body aim to enrich the world.

With this reservation I would be inclined to say that *modesty* is the attitude of mind which has contributed most powerfully to mathematical progress. The great "Elements" of Euclid, for instance, are candidly based on assumptions or axioms and do not claim to prove everything *ab initio*. Moreover, this great work does not concern itself directly with such fundamental questions as truth, reality, life, death, etc., but it confines itself to deductions relating to matters which might appear as trivialities when compared with many other problems which then confronted and now confront the human race.

To understand the modesty of Euclid and his geometric predecessors it is necessary to bear in mind the fact that the "Elements" of Euclid were written at a time when other sciences made little or no demand for such results as these "Elements" embodied. Even such a closely related subject as surveying could then make little direct use of these results in view of the theoretic form in which they were presented. The work which is said to have passed through more editions than any other book except the Bible, which considers diametrically opposite questions, must have appeared to many of Euclid's contemporaries as dealing with comparatively trivial matters in a modest way, since it made no attempt to trace its fundamental principles to their sources, but explicitly started with axioms or postulates.

As another evidence of modesty in mathematics I may mention the special symbols for unknowns and the use of equations in these unknowns. The scientific method embodied in equations involving at least one unknown implies the careful study of relations involving something with respect to which we have openly acknowledged our ignorance. Like the axioms or postulates of geometry, it makes no pretention of complete knowledge, but is satisfied with an humble attitude of mind. The basis of mathematical development is thus seen to be characterized by a modesty which has led the investigator to do what he can do thoroughly rather than to try to do that which would naturally interest him more but which lies beyond his power.

Even in its most primitive form, count-

ing, mathematics clearly dealt with matters of secondary importance. Is not the finger more important than the number attached to it in view of its position in relation to the other fingers? Why should the primitive races then have turned their thoughts away from the most important to matters of secondary importance? As I understand it, this turning away from unfathomable but most enticing difficulties to the fathomable but less enticing ones is the great keynote of science, and mathematics was perhaps the first scientific subject to sound this keynote with decided clearness. It was, however, not always sounded with clearness by mathematicians. The Pythagoreans, for instance, endeavored to make it appear that numbers were endowed with noble properties which are entirely foreign to them. They were not yet sufficiently modest to study mathematics most effectively, and their spirit has its representatives even in our day.

The picture representing the attitude of mind which contributed most powerfully to mathematical investigation would, however, not be complete without uniting with modesty discretion and a love for mental travel and exploration. The traveler and the explorer are usually first attracted to regions which are easily accessible and whence it is easy to retrace one's steps. The attitude of mind which is exhibited by the common expression "safety first" has been largely responsible for the trend of developments in mathematics. With the passing of years these safe permanent thought roads have acquired historic interest and they have naturally been used as models by those who aim to open up scientific regions where mire and quicksand impede progress, and sometimes engulf roads which had been supposed to be secure.

The chief function of mathematics in scientific research is, however, not the cultivation of a feeling of modesty or of a desire for mental travel and exploration. The problem of the mathematical investigators is a much more difficult one, since it relates to the discovery and development of unifying processes which are sufficiently comprehensive to avoid bewilderment as a result of a maze of details, and yet sufficiently close to the concrete to become useful in the widely separated fields of scientific endeavor. With the growth of scientific knowledge in various fields, the problems of the mathematical investigators becomes more complex, and the world has never been in greater need for more mathematics than at the present time, since civilization never before called so loudly for perspicuity in science.

It is not an easy matter to characterize briefly and yet clearly the function of mathematics in the broad field of scientific endeavor. A prominent feature of mathematical work is that it changes postulates or assumptions into different forms, which are sometimes more readily accessible for experimentation than the original postulates were or are more directly useful in the solution of other scientific difficulties. The transformation of postulates, or accepted conclusions, is not peculiar to mathematics, but is common to all sciences. In mathematics these transformations, or the results derived therefrom, serve as a means to obtain new transformations, while in the other sciences they serve as a means to wrest from nature a new truth. Mathematics is commonly guided by current hypotheses about nature in the selection of her postulates, but after these are once selected, she is interested in building up a world for herself by constructions which are necessary consequences of these postulates. If these constructions represent only a small fraction of the interesting questions which appear to become clarified by logical

processes, mathematicians are perhaps not to be blamed for their reluctance in leaving extensive developments, which seem to admit of growth in every direction, for new fields where mathematical insight appears more or less uncertain.

The mathematicians, therefore, may be regarded as the old conservative party among scientists. They are the standpatters among the scientists of to-day. This does not say that they are making no progress. On the contrary, they have made and are making rapid progress, and are entering new fields, but fortunately the world is moving ahead so rapidly scientifically that no scientific party is able to embody in its platform all the desirable new features. In times of revolution conservatism is not apt to be popular, and in the midst of the scientific revolution in which we are finding ourselves the mathematical party is naturally receiving blows which the calmer days of the future will doubtless declare to have been too severe. These blows tend at the present time to work downward into our elementary and secondary education and they ought to be matters of great concern for all scientists; for, without the clarifying influence of mathematics, the whole structure of science would suffer seriously.

In recent decades the churches of our land have tended towards unity in action and towards a higher appreciation of the merits of the great common principles. Is it not likely that what is common to all the sciences, viz., the formation of ideas and the investigation of relationships existing between these ideas, will receive more emphasis as we understand better the value of scientific work? Monopoly in science is the worst type of monopoly. Mathematical ideas have an unusually wide range, but are comparatively barren in local content, for the richer an idea is, as regards local content, the poorer it usually is as regards range.

The present movement to organize research work is strongly represented in England by the Imperial Trust for the Encouragement of Scientific and Industrial Research and the Advisory Council. In America this same movement is represented by the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science, appointed in 1914,[2] and its various subcommittees appointed in 1916, and by the National Research Council, organized on September 20, 1916, by the National Academy of Sciences at the request of the President of the United States, and its plexus of committees representing the various domains of science.[3] This movement should tend to emphasize the common ground of scientific research as well as to clarify the atmosphere by directing attention to the fact that there are many grades of scientific research. It should be emphasized that the greatest danger of research to-day is that its popularity tends to research hypocrisy.

While the common ground of scientific research can not be said to be mathematics at the present time, it will doubtless be admitted that its ideal is mathematics. In fact, this common ground consists largely in so coordinating facts of observation or deduction as to lead to certain conclusions. These conclusions are not always necessary, but with the advance of knowledge they naturally tend towards becoming necessary. As soon as the conclusions become necessary, if certain explicit assumptions are made, and are not merely very probable, the reasoning becomes mathematical. Mathematical reasoning thus appears to be the goal towards which scientific reasoning is striving, and lack of sufficient knowledge furnishes the main reason why mathemat-

[2] Science, N. S., Vol. 39 (1914), p. 680; Vol. 45 (1917), p. 57.

[3] *Proceedings of the National Academy of Sciences*, Vol. 2 (1916), p. 607.

ical reasoning is not now more commonly used in scientific research. This may serve to explain the following assertion recently made by Professor H. S. White:

> Most scientists can and will become mathematicians when their special problems reach the stage where measurements are possible.[4]

It may be desirable to direct attention to the fact that the mathematician might almost be said to cease to be a mathematician when he becomes an investigator. It is true that he needs a large and growing amount of mathematical knowledge in order to investigate successfully. The flood of valueless literature contributed in recent years by non-mathematicians who endeavored to solve the great prize problem, known as the Greater Fermat Problem, has emphasized the fact that, in mathematics, as well as in other sciences,

> important advances in knowledge are far more likely to issue from the expert than from the inexpert. Indeed, the probability of extending knowledge by organizations conducted by disciplined investigators is so much greater than the probability of extending knowledge by the dragnet method that we not only may but should ignore the latter in comparison with the former.[5]

The mathematical investigator can clearly not afford to forget his knowledge of mathematics, but it is questionable whether he can afford to confine himself to mathematical reasoning while he is aiming to advance his subject. He needs imagination and ability to foresee results long before his mathematical machinery has enabled him to establish them. Unless we become like children in faith and fancy, we should not expect to add much that is fundamentally new to the kingdom of mathematics. As investigators we all have much more in common than as students of what has been done by others, and this common ground naturally increases with the originality of our investigations.

This common ground of investigators may serve to explain the fact that many of the most influential research organizations, like the National Academy of Sciences in our own country, embrace all the sciences. In recent decades there has been a tendency to organize research separately in the various subjects in the form of national societies named after these subjects. In fact, there are those who think that the latter have assumed such a preponderant sphere of influence as to threaten the very life of the former as serious factors in research. On the other hand, the maintenance of a common scientific life seems to be of the highest importance in view of desirable interactions and special emphasis on what is most fundamental.

The history of mathematics has taught us that some subjects which were apparently far apart and which were long developed separately were later seen to have most important common elements. The discovery of these common elements and their development has led to marked advances in the separate fields themselves. By way of illustration I need only refer to the fields of algebra and geometry so happily welded through the work of Descartes, Fermat and many others. In modern times the theory of groups and invariants has exhibited many important connections between subjects which had been supposed to be widely separated. The same tendency has, of course, manifested itself in other sciences and may be assumed to become more dominant as knowledge advances.

A pertinent difference between the mathematical investigators and investigators in other sciences is that the former are compelled to stay with their problems until a solution is reached which can be proved to be in accord with deductions from certain definite assumptions, while the latter enjoy

[4] H. S. White, SCIENCE, N. S., Vol. 43 (1916), p. 587.

[5] R. S. Woodward, SCIENCE, N. S., Vol. 40 (1914), p. 221.

much greater freedom in regard to the stage to which they may pursue a problem before announcing results. Hence these may hope for success in dealing with much more difficult questions than the mathematician could reasonably hope to solve at the present time. The limitations thus imposed upon the mathematician are compensated, at least in part, by the finality of his results as regards questions of rigor. Mathematical results *can* never be disproved, other accepted results *have* never been disproved. With respect to simplicity and style, the mathematical developments are seldom final, and in many cases, they appear to admit endless variations.

As instances of final mathematical results may be cited the useful tables which when once computed serve all succeeding generations. Such finality may be said to be a goal of all scientific endeavor, since the results enrich countless ages by increasing their capacity for accomplishments. In fact, such tables may be regarded as typical illustrations of the mathematical contributions to the advancement of knowledge even if they constitute a very minor portion of these contributions. The fact that mathematical results have increased the capacity of the world for doing things may be emphasized by noting, in particular, that in recent years prime numbers have been found which could not have been proved to be prime by the method employed by Eratosthenes, if the entire human race had been working in an organized manner on this single problem since the days of the ancient Greeks.

The present seems to be an especially appropriate time to consider the interrelations of scientific research in view of the rapidly growing public appreciation of the value of such research. Several decades of comparative peace immediately preceding the present great and deplorable conflict were unusually rich in great scientific triumphs. As well-known instances we may cite wireless telegraphy and the construction of the great Panama Canal, which became possible by our advanced knowledge in regard to sanitation. The world-wide health activities under the auspices of the Rockefeller Foundation and the activities of our agricultural colleges in directing attention to advantages resulting from scientific methods of farming are strong forces working towards a popular appreciation of science. Since the great European war began it has become evident through the new elements introduced by the submarines and other scientific devices that the very existence of a great nation may depend upon the scientific attainment of its people, and hence the question of scientific research has taken a prominent place among those of national policy. It is perhaps significant that our National Academy was founded in the midst of the Civil War.

Scientific research is as old as civilization and has often been protected by kings in a patronizing manner, but it is a new experience in the history of the world to see kings turn to scientific research for protection. For centuries governments have recognized the value of science and have provided with growing liberality for her development, but now they are calling to her to save them from destruction. They have noticed that in spite of many excellencies in other directions the ignorance of causes may entail their destruction as separate nations. This new attitude towards our field of work may at first tend to gratify us, but a second thought reveals the fact that it is fraught with grave dangers. Kings in government and finance are interested in the dead results of science instead of in the great living and growing organism itself, whose growth seems to have just begun and whose development has always been more keenly inspired by love of truth than by hope of gain.

Is there not a danger that the sudden recognition of the great political importance of certain types of research will have somewhat the same effect on science as the discovery of gold in California and in Australia about the middle of the preceding century had on the development of the regions concerned? People flocked from one mining camp to the other and often neglected duties which are essential for the harmonious development of the resources of a country. Hence there seems to be a special need at present to urge our colleagues to remain at their posts of duty, notwithstanding glowing reports of chances to amass scientific fortunes quickly in certain newly discovered gold fields. The get-rich-quickly schemes in science should be scrutinized as carefully as similar schemes relating to the accumulation of money.

The remaining at one's post of duty in scientific research does not imply a lack of support in the solution of pressing problems or a lack of vacation trips and acquaintance with other fields of work. In fact, such support and acquaintance are highly desirable. It is, however, a question whether the nomadic scientific life, which seems to have become fashionable during the last few decades, at least in mathematics, is the one which will in the long run bring the best results. Science is not primarily a grazing country. Large tracts are suited for agriculture and mining. What is new is not necessarily good and what is good is not necessarily new, and prophesies in regard to the great importance of certain new developments have not always been fulfilled. On the other hand, it should be remembered that reasonable hope and optimism are essential for progress, and that we need prospectors as well as miners in the scientific world.

It should be noted that the miner needs some of the qualifications of the prospector since he is apt to meet with new situations and needs to take advantage of the available by-products. In fact, while he is mining for gold he may strike deposits of copper which are richer than the gold deposits which he was primarily seeking. Some of the richest mathematical discoveries were made while the investigator was looking primarily for other results, and even problems which have not been solved at all up to the present have been the source of very useful developments. I understand that similar conditions hold in other fields of scientific effort and these facts point to the great importance of freedom on the part of the investigator, and, incidentally to the danger of too much organization in scientific research.

As a very recent instance of an unexpected mathematical by-product, I may be pardoned for referring to a somewhat trivial case which has, however, the important property that it can be understood by all. It is well known that the theory of substitution groups was developed for the purpose of clarifying the theory of algebraic equations and not for the purpose of adding to the enjoyment of parties engaged in playing games of cards. In fact, the study of such an advanced mathematical theory as that of substitution groups might appear to involve concepts, which are at the opposite pole from those entering the minds of people seeking recreation at card tournaments.

Notwithstanding this apparent wide separation, I was pleased to be able to say recently to a friend, who desired to have each one of a large party play once and only once with each of the others during a series of successive games, that an arrangement of the players meeting this condition could be determined directly by means of substitutions of certain transitive groups. This should perhaps have been expected, since a transitive substitution group is an ideal republic treating all its letters in exactly the

same way. On the contrary, an operation group may have elements enjoying special privileges and hence it has more extensive contact in the actual world of thought.

A little study of the stated problem revealed the interesting fact that when the number of tables is any power of 2 the substitutions of a well-known type of substitution groups and its group of isomorphisms exhibit directly how the players can be arranged so that each one will play once and only once with, and twice and only twice against, each of the others in a certain series of games. To make myself perfectly clear, I may say that if 8 tables, or 32 players, are involved, one can write directly by means of a certain regular substitution group of order 32 a set of possible arrangements so that in 31 successive games each one of these 32 players would play once and only once with each of the others and twice and only twice against each of them. This was, however, not the first solution of the general problem in question. In fact, about twenty years ago Professor E. H. Moore published a different solution of it in Volume 18 of the *American Journal of Mathematics* under the title "Tactical Memoranda."

I have referred to this matter here mainly for the purpose of emphasizing the fact that intellectual penetration is often attended by the most unexpected by-products, but I should also be pleased to have people know that certain kinds of recreation can easily be enriched by making use of results which the mathematician developed for a totally different purpose. Science should and does enrich both work and play. More than a thousand years ago the Hindu astronomer Brahmagupta said:

> As the sun obscures the stars, so does the proficient eclipse the glory of other astronomers in an assembly of people by the recital of algebraic problems, and still more by their solution.[6]

[6] H. T. Colebrooke, "Algebra with Arithmetic and Mensuration from the Sanscrit," by Brahmagupta and Bhascara, 1817, p. 379.

The playful question, Where do the finger nails find so much dark dirt to put under them? may serve to arouse a thoughtful attitude on the part of the boy who has been taught to keep his hands clean. In fact, our play and recreation are perhaps as fundamentally affected by questions of science as our serious work and the victrolas and moving pictures should have a marked influence on the popular attitude towards science in view of the fact that they reach so many people. If it is true that the greatest service which science is rendering the human race is the reduction of superstition, it is clear that the efficiency of science depends largely upon its popularity.

The hypothesis that space and the operations of nature are discontinuous clearly excludes the hypothesis that they are continuous, but it is interesting to note that the mathematics relating to the discontinuous does not exclude that relating to the continuous. On the contrary, there are the most helpful interrelations between these two types of mathematics. Such a subject as number theory, relating decidedly to discrete quantities, has been greatly extended by analytic methods relating to continuous quantities, and, on the other hand, processes relating to the study of continuous functions are largely based upon those relating to the discontinuous.

This may perhaps tend to show that even if our hypotheses in regard to the continuity of space and the operations of nature have to be largely modified, as seems now probable, the mathematical methods of attack may require less modification than might at first appear to be necessary. The language which mathematics has provided for science includes not only concepts relating to the continuous and the discontinuous, but fortunately it also shows relations between these concepts and these relations

become more pronounced with its development.

In view of the age of this language and its contact with various sciences it may be readily understood why mathematical history occupies a prominent place in the history of science. In fact, the history of science constitutes one of the fields where scientists may find common interests most fully represented, even if the past is too rich in events to be studied completely. It may therefore be appropriate on this occasion to refer to a few recent developments relating to the history of mathematics, especially since the interest in the history of science has increased rapidly during recent decades, as is partly evidenced by the efforts that are now being made to establish an institute of historical scientific research in our land.

One of the most interesting questions relating to the early history of mathematics is the use of positional values of numbers and the closely connected use of a symbol for zero. Until a decade or two ago it was commonly assumed by mathematical historians that the use of zero as a positional number symbol originated in India, and this view has not yet been entirely abandoned, notwithstanding the fact that the Babylonians employed numbers with positional value and a symbol which seems to have fulfilled the main function of our zero several centuries before the Christian era. On the other hand, the first definite evidence of the use of zero among the Hindus falls in the second half of the first millennium of this era.

In view of these facts it is extremely interesting to note the early use of zero, in connection with numbers having positional value, by the Maya, a people inhabiting the Atlantic coast plains of southern Mexico and northern Central America. One of the worthy alumni of your university recently referred to this matter in the columns of SCIENCE in the following words:

> Special interest attaches to the occurrence of zero-symbols and the principle of local value among the inhabitants of the flat lands of Central America, at a period as early as the beginning of the Christian era, if not much earlier. It would seem that in this invention, the Maya in Central America possessed priority over Asiatic people by a margin of five or six centuries.[7]

If further investigation will lead mathematical historians to agree that the zero as a symbol in a numerical notation with positional value was actually first used in America, according to the preserved records, it will effect a very fundamental change as regards interest in the early mathematical attainments of the American aborigines. Unfortunately these early mathematical attainments failed to become the source of extensive further developments on American soil. They exhibit clearly that central concepts may be discovered independently and they direct attention to the danger in trying to establish one source for a particular concept in historical investigation. They also show that the small strip of country marked now by Boston has not always been the intellectual hub of America.

The history of some of the mathematical attainments of the Maya people has recently been made more easily accessible through the publication of "An Introduction to the Study of the Maya Hieroglyphs," prepared by S. G. Morley and published as Bulletin 57 of the Bureau of American Ethnology, Smithsonian Institution of Washington. On page 92 of this bulletin a dozen different symbols for zero are noted and on page 131 numbers varying from 21 to 12,489,781, and involving the use of zero, are represented in the Maya notation. It is of interest to note that the

[7] F. Cajori, SCIENCE, N. S., Vol. 44 (1916), p. 715.

value of a unit in a higher position is always 20 times the value of a unit in the next lower position, except in the case of the third place, where its value is only 18 times that of the second place.

In historical research and elsewhere, the mathematician seeks cordial cooperation with other scientists, and he regrets that the confusion of tongues, resembling the experiences at the tower of Babel, is making it more and more difficult to understand each other. In the case of scientists this confusion is mainly due to a rapid growth of language in various directions. May we not hope that as many theories which were supposed to be distinct suddenly exhibited profound connections, so also this extensive language will tend towards unity and simplicity as we see more clearly the fundamental underlying principles. Science knows no bounds in method or in subject-matter and the artificial limitations set by man for his own convenience in making a start must break down before the onward march of truth. All science is a unit and all scientific investigators should be inspired by their common interests.

G. A. Miller
University of Illinois

SCIENTIFIC EVENTS

FORESTRY ORGANIZATION FOR THE WAR

A "forestry regiment," made up of foresters, practical woodsmen, loggers, portable sawmill operators and others experienced in lumbering operations, for service in France, will, it is announced, be raised immediately. The Forest Service, at the request of the War Department, will prepare plans for the organization and equipment of the force and will aid in securing suitable men. The regiment will form a unit of the Engineer Corps now being recruited to be sent abroad as soon as it can be organized and equipped.

The organization of this regiment is the result of a suggestion made by the British Commission. Similar forces have been raised in Canada and are rendering valuable services. The object of the American forestry regiment, it is said, will be to convert available timber into material suitable for bridges, railroads, trenches and other construction work with the least possible waste. At the same time the cutting will be done under the supervision of technical experts in cooperation with the French foresters. In this way the permanent damage to the forests incident to furnishing the imperatively needed timber, it is hoped, will be kept as small as possible.

The regiment will be organized in units capable of handling all kinds of woods work and will include a number of portable sawmill outfits. It will be officered by trained foresters and expert lumbermen who are thoroughly familiar with producing and delivering lumber. It will carry complete equipment for all kinds of woods work. The classes of men desired comprise axemen, teamsters, tie-cutters, millwrights, saw-filers, sawyers, portable sawmill men, farriers, blacksmiths, lumberjacks, cooks and carpenters, as well as motorcycle and motor-truck operators. As rapidly as enlistments are secured, the men will be assembled at six central points, which have already been designated.

EXPEDITIONS OF THE SMITHSONIAN INSTITUTION

A letter from Mr. H. C. Raven recounts the collection of many kinds of wild rats, shrews, bats, squirrels, etc., made in the East India Islands. The first shipment received at the National Museum included 319 mammals and about 300 birds. Mr. Raven recently explored the central part of Borneo, thence working southward by cart and pack train, and is now supposed to be in the southern part of the island. Another collection of miscellaneous matter just received from Mr. Raven includes ethnological specimens, mammals, birds, also reptiles, shells and insects.

Mr. Arthur deC. Sowerby, who has been exploring in China for the National Museum, has not been very successful owing to the conditions there, but managed to visit Shanghai and several places on the lower Yangtze. A

letter from him reports as follows: "My recent trip, to Che Kiang was brought to a summary close by the outbreak in that region. I could not get any transport and very nearly had my retreat cut off. Nothing can be done until the provinces have come to an agreement as to just how the government is to be run. There is only north Chili (a province of China) left to work in and I hope to go there in the autumn. China is in such an unsettled state that if it were not for the war in Europe it would be attracting everybody's attention. Conditions are no better than they were during the revolution of 1911."

Dr. W. L. Abbott, who has enabled the institution to take part in much field work during the past thirty years, and who is now financing the explorations of Mr. Raven, has made a short collecting trip to Santo Domingo. On this island, which was the scene of Dr. Abbott's earliest expedition, in 1883, he collected a number of mammals, birds, reptiles, mollusks, insects and Indian relics.

Mr. John B. Henderson, a regent of the Smithsonian Institution, has conducted a series of dredgings from his yacht *Eolis* off Key West, Florida. Owing to the exceptionally good weather conditions and to the fact that the Gulf Stream had receded much farther off shore than is usual, the party was enabled to carry on most successful operations upon the Pourtales Plateau. This is a strip of rocky bottom off the Florida Keys extending some forty or fifty miles and lying between the depths of 100 and 200 fathoms. It is one of the richest localities in American waters with a fauna peculiarly its own. The material collected covers all groups of marine invertebrates.

Dr. Paul Bartsch, of the National Museum staff, and Mr. John B. Henderson, also collected in Cuba, the Florida Keys, and in Florida, where marine invertebrates were secured by dredging. The Cerion Colonies composed of land mollusks from the Bahamas, planted some time ago by Dr. Bartsch in the Florida Keys, as an experiment to discover the effect of the environment, were examined. Observations and notes were also made on the birds seen on the islands visited.

APPROPRIATIONS OF THE GENERAL EDUCATION BOARD

THE General Education Board, disbursing moneys from the John D. Rockefeller Fund for the promotion of education, has announced annual appropriations amounting to $878,004. It is announced also that since the University of Chicago has raised $3,461,500 for its medical school, subscriptions of the General Education Board and of the Rockefeller Foundation, amounting to $2,000,000, become valid at once.

By a final gift of $350,000 to the Johns Hopkins Medical School the board announced that it had completed its contribution of $1,750,000 for full-time medical teaching in that institution. When the board announced the first of its gifts for the reorganization of the departments of medicine, surgery and pediatrics in Johns Hopkins, the total contributions were set at $1,400,000.

Aims of the board in making the gift were expressed then by the Rev. F. T. Gates, then chairman, in these words: "We think it important that the clinical subjects should be cultivated and taught by men freed from the distraction involved in earning their living through private practise. They will henceforth be in a position to do any service that either science or humanity demands." The fund thus completed is known as the William H. Welch Endowment for Clinical Education and Research.

In announcing the release of the money for the University of Chicago the board added that its policy was to "use its funds with a view to inducing others to cooperate toward the same ends. Thus its contributions for nearly all purposes are supplemented by other gifts secured through the cooperation of the General Education Board."

Annual appropriations to other funds and for other educational purposes as planned in former years were:

To Monmouth College, Monmouth, Ill., $60,000 toward a total of $250,000.

To Ottawa University, Ottawa, Kan., $100,000 toward a total of $400,000.

For professors of secondary education in state universities, $35,130.

For state agents for rural schools, $53,200.

For rural education of negroes, $50,974.

For current support of negro colleges and industrial schools, $102,200.

For farm demonstrations, including canning club work and boys' corn and tomato clubs in Maine and New Hampshire, $36,500.

Additional appropriations for various projects, aggregating $80,000, of which the sum of $50,000 was given for the purpose of promoting educational studies and research.

In making this last appropriation of $50,000 for educational research the board is continuing a policy begun two years ago.

It was also announced that Frederick T. Gates, who has been Mr. Rockefeller's adviser in benefactions for many years, had resigned from the chairmanship of the board. He is to be succeeded by Dr. Wallace Buttrick, who has been secretary. Mr. Buttrick's place is taken by Dr. Abraham Flexner.

THE RAMSAY MEMORIAL FUND

As was noted in Science at the time a public meeting was held last October at University College, London, to consider the best means of establishing a memorial to the late Sir William Ramsay. We learn from *Nature* that since then the organization of the appeal has been set up and is now complete. Mr. H. H. Asquith has consented to act as president of the fund, whilst the vice-presidents include the ambassadors and ministers of allied and neutral powers, Mr. Lloyd George, the president of the Board of Education, the president of the Royal Society and the chancellors of the universities of Cambridge, Glasgow and London. The general committee, consisting of the subscribers, is under the chairmanship of Lord Rayleigh. Lord Glenconner and Professor J. N. Collie share the office of honorary treasurer, and Dr. Smiles is acting as honorary secretary.

An executive committee, formed under the chairmanship of Sir Hugh Bell, has drawn up an appeal, which is at present only privately issued, but will shortly be circulated publicly. The committee aims at obtaining a sum of £100,000, and whilst the final form to be taken by the memorial will be submitted to the subscribers, and will necessarily depend on the amount obtained, the objects recommended are: (1) The provision of Ramsay Research Fellowships, tenable wherever the necessary equipment may be found; and (2) the establishment of a Ramsay Memorial Laboratory of Engineering Chemistry in connection with University College, London, where Sir William Ramsay's most important discoveries were made during his twenty-six years' tenure of the chair of chemistry. The committee has also in mind the inclusion of other forms of memorial, such as the institution of a Ramsay Medal for Chemical Research.

The sum already obtained by the private efforts of Sir William Ramsay's friends and from their own generosity amounts to about £13,500. This includes the donation of £5,000 from Messrs. Brunner, Mond, Ltd.; £1,000 each from the Rt. Hon. Lord Glenconner, Sir Hugh Bell, Sir Ralph C. Forster, Sir Robert Hadfield, Mr. Robert Mond and Mr. Hugh Brunel Noble; and £500 each from the president of the British Science Guild and Miss Lilias Noble.

SCIENTIFIC NOTES AND NEWS

The New York Academy of Sciences has been compelled to postpone the celebration which had been planned, but on the evening of May 28 the following program was given in honor of the one hundred years of scientific activity of the academy:

The relation of pure science to the national crisis: Professor Michael Idvorsky Pupin, president of the academy.

The academy's scientific survey of Porto Rico: Dr. Nathaniel Lord Britton.

Our first hundred years—a summary: Dr. John Hendley Barnhart.

Professor T. H. Morgan, of Columbia University, has been elected a foreign member of the Linnean Society, London.

Dr. Isaiah Bowman, director of the American Geographical Society, was in April awarded the Bonaparte-Wyse gold medal of the Geographical Society of Paris for his explorations in and publications on South America.

WE learn from *Nature* that the Pereira prize of the Pharmaceutical Society of Great Britain has been awarded to Miss Ivy Roberts, and the silver and bronze medals of the society have been awarded, respectively, to Mr. H. Jephson and Miss Doris Gregory. The Hanbury gold medal has been awarded to Professor H. G. Greenish, professor of pharmaceutics to the Pharmaceutical Society.

THE Swedish Society of Physicians has elected Colonel Robert Jones, C.B., inspector of British military orthopedices, to be a foreign member.

THE Jacksonian prize of the Royal College of Surgeons of England for 1916 has been awarded to Mr. E. W. H. Groves for his dissertation on "Methods and results of transplantation of bone in the repair of defects caused by injury or disease." The subject for the Jacksonian prize for 1918 is "The injuries and diseases of the pancreas and their surgical treatment."

The British Medical Journal states that the post of director of the Institute for Experimental Therapy and of the Georg-Speyer House in Frankfurt-a.-Main, left vacant more than a year and a half ago by the death of Professor Ehrlich, has been given to Professor Kolle. He was one of Koch's pupils, and was his assistant when he investigated the causes of rinderpest in British South-west Africa in 1896. Kolle was then only twenty-eight. In conjunction with Pfeiffer, he investigated the problems of typhoid immunization, and the typhoid vaccine experiments carried out at the time of the Herero rising were continued during the present war. He has also made observations on cholera, plague and dysentery.

IT was announced at a resumed annual meeting of the Iron and Steel Institute of Great Britain that awards had been made by the council from the Carnegie Research Scholarship Fund to the following: Mr. W. C. Hancock, £50, to enable him to continue his investigations on refractory materials, with special reference to the manufacture of coke-oven bricks; to J. L. Nauchton and D. Hanson, a grant of £100 to enable them to continue their joint research on iron-phosphorous and iron-carbon-phosphorous steels; to J. Hurst a grant of £100 for an investigation on the wearing and the micro-structure of worn cast-iron specimens; to J. H. Whiteley and A. F. Hallimond, a grant of £100 for a joint research on the chemical detection of strain in iron and steel.

CHANCELLOR DAY, of Syracuse University, has appointed the following representatives from the faculty, trustees and alumni to act as the local Research Council: Dr. C. W. Hargitt, *chairman*; Professor E. N. Pattee, *secretary*; Dean W. P. Graham, Acting Dean Frank F. Moon, Dr. Frank P. Knowlton, Mr. Edmund L. French, Mr. William J. Harvie.

PROFESSOR GEORGE R. MCDERMOTT, the professor of structural design in Sibley College, has been appointed a member of the staff of General George W. Goethals, who is taking charge of the construction of an emergency fleet.

DR. ALLERTON S. CUSHMAN, president of the Institute of Industrial Research, with headquarters at Washington, has been commissioned a major in the Officers' Reserve Corps, and will do special research work under the ordnance section on the chemistry of high explosives.

MR. HARRY S. SWARTH has accepted the position of curator of ornithology and mammalogy in the museum of the California Academy of Sciences, and will enter on the work on October 1. Mr. Swarth has been curator of birds in the museum of vertebrate zoology of the University of California since 1915. He is a fellow of the American Ornithologists Union.

DR. THOMAS CROWDER, medical director of the department of sanitation and medicine of the Pullman Company gave a lecture on May 14 at the University of Illinois College of Medicine, his subject being "Ventilation and sanitation of sleeping cars."

THE Bakerian lecture of the Royal Society was delivered by Mr. J. H. Jeans on May 17 upon the subject of the configuration of astronomical masses and the figure of the earth.

Sir William Osler delivered the annual oration of the Medical Society of London on May 14. His subject was "The anti-venereal campaign."

The Sydney Ringer biennial memorial lecture was delivered on Friday, May 25, at the University College Hospital Medical School, London, by Professor A. R. Cushny, on "Digitalis and auricular fibrillation."

A statue of Berthelot, the great chemist, has been unveiled in the gardens of the Collège de France. He did much of his work in the laboratories of the college.

Miss Nellie Fosdick, instructor in botany at Wellesley College, died on May 19.

Miss Ruth Holden, Alice Freeman Palmer fellow in botany at Wellesley College from 1914 to 1915, has died in Moscow, Russia, from typhoid fever, contracted during her work as a member of the Red Cross relief work for Polish refugees in Russia.

Sir Marc Armand Ruffer. distinguished for his work in preventive medicine, has lost his life while engaged in Red Cross work.

Major P. G. Bailey, known for his work in genetics, was killed in action on April 26.

The death is announced at Paris of Louis Landouzy, known for his work in tuberculosis, aged seventy-two years.

Professor H. F. E. Jungersen, professor of zoology and director of the zoological museum in the University of Copenhagen, has died at the age of sixty-three years.

A new journal for physical anthropology has been established in Italy. It will be known as the *Giornale per la Morfologia dell' Uomo e dei Primati,* and is edited and published by Professor G. L. Sera, of the University of Pavia.

The Angrand prize of the Bibliothèque Nationale of Paris, of the value of 5,000 francs, is to be awarded in 1918 for the best work published during 1913–17 on the pre-Columbian history, ethnography, archeology or linguistics of the American aborigines.

We learn from the *British Medical Journal* that the triennial prize of the Royal College of Surgeons of England, consisting of the John Hunter medal in gold to the value of fifty guineas, or, at the option of the author, a medal executed in bronze, with an honorarium of £50, will be awarded for the best essay on "The development of the hip-joint and the knee-joint of man." Essays must be received at the college not later than Tuesday, December 31, 1918. The subject of the Jacksonian prize for this year, essays in competition for which must be received on December 31, 1917, is "The causation, diagnosis and treatment of traumatic aneurysm, including arterio-venous aneurysm." As already announced, the subject of the prize for 1918 is "Injuries and diseases of the pancreas and their surgical treatment."

The Lakeside laboratory of the Iowa State University on the shores of Lake Okoboji, begun nine years ago by President Emeritus Thomas H. Macbride, will open its annual session on June 18. The staff of instruction, in addition to members from the university, will include Professor T. C. Stephens, of Morningside College, zoology, and Mr. A. F. Ewers, of St. Louis, botany. Dr. F. C. Stromsten, of the university, has charge of work on aquatic animals. Professor R. B. Wylie, also of the university, is the director.

The annual summer courses which are given at the marine station of the University of Washington, Friday Harbor, are scheduled to begin on June 18, and will last six weeks. The work this session will be on the development of marine animals and will be under the supervision of Hjalmar L. Osterud, instructor in zoology at the university. He will be assisted by Dr. John Bovard, professor of zoology in the University of Oregon, who will give the general course in marine zoology. Dr. H. S. Brode, of Whitman College, will lecture in ecology, while Dr. Theodore C. Frye, professor of botany at the State University, will teach algology.

Professor Nelson C. Brown, head of the department of forest utilization at the New York State College of Forestry, Syracuse University, has obtained a leave of absence for one year and a half, and will go to Europe as a government trade commissioner in an investi-

gation of the lumber needs of the warring nations for reconstruction purposes. Early in May, the trade commissioners met at Washington for the purpose of organization. There they gathered data concerning tariffs, freight rates, probable future shipping facilities and other information bearing on the matter of lumber exports after peace has been declared. They will spend two or three months in visiting lumber-producing centers in this country, interviewing lumbermen. This preliminary work will be for the purpose of obtaining exact knowledge as to how much lumber the European countries now at war can purchase here and in what particular markets. Professor Brown and his associates expect to sail for Europe in August or September.

THE Johns Hopkins *Alumni News* states that it has lately become known that two of the most successful devices introduced by the allies in the present war are due to Dr. Robert W. Wood, professor of experimental physics. They are the lachrymose or "tear" gas, used to render the enemy temporarily blind, and a photographic screen of a special type, which is especially well suited to the requirements of modern warfare. Dr. Wood sent the formula for the former to a friend in Paris soon after the outbreak of the war. Several weeks after submitting his plan, Dr. Wood received word that it had been turned over to the proper authorities. Nothing was done, however, until three months later when the Germans began the use of poisonous gases; since then the tear gas proposed by Dr. Wood has been used on both sides. The gas has a powerful effect on the eyes, the slightest trace closing them and starting the tears. It is benzyl-bromide, or choracetone, vapor and produces temporary blindness but not permanent injury. Its use was in no way a violation of The Hague conventions or the usages of civilization. It was Dr. Wood's idea that the gas might be used in a single great drive, being released over the whole battle front simultaneously. The other of Professor Wood's inventions being used extensively in the fighting on the west front is the infra-red screen for the panchromatic plates for photography. By the use of the screen the Allied airmen are enabled to obtain accurate photographs of the enemy's position, batteries, etc., right through the thick pall of smoke which hides them from view.

UNIVERSITY AND EDUCATIONAL NEWS

YALE UNIVERSITY has received from Mrs. Edward H. Harriman, of New York, bonds yielding $4,600 a year for the purpose of establishing the Harriman Fund for Orthopedics.

THE late J. T. Apperson, member of the board of regents of the Oregon Agricultural College since its founding and at one time president of the board, left the residue of his estate to the trustees of the college as a permanent loan fund to worthy students who make their own way through school. The benefaction will amount to from $25,000 to $40,000, and will be invested by the State Land Board.

THE new building of the dental school of Western Reserve University is nearing completion and will be occupied in the fall of 1917. The building is situated alongside the university campus and near the site for the new medical school plant. The dental school, formerly affiliated, is now an integral department of the university. An extensive revision of the curriculum and an increase in entrance requirements are contemplated.

SIR CHARLES HOLCROFT bequeathed to the University of Birmingham the sum of £5,000 for research work in science. Sir Charles Holcroft contributed, during his lifetime, about £100,000 to the university.

THE board of trustees of the Long Island College Hospital announces the appointment of Dr. James C. Egbert, director of extension teaching, Columbia University, as president of the medical college. Dr. Otto V. Huffman has been appointed dean; Dr. Wade W. Oliver, formerly of the University of Cincinnati, has been called to the chair of bacteriology and Dr. Carl H. Laws, formerly of the department of pediatrics in the University of Michigan, has been appointed professor of pediatrics.

DR. J. BRONSENBRENNER has resigned the position of director of research laboratories of the Western Pennsylvania Hospital in Pittsburgh to accept the appointment of associate

professor in the department of hygiene at the Harvard Medical School.

Dr. George D. Louderback has been advanced from associate professor to professor of geology at the University of California.

Professor D. L. Crawford, of Pomona College, Claremont, Cal., has been appointed professor of entomology in the College of Hawaii, Honolulu, for a term of three years, beginning in September, 1917.

DISCUSSION AND CORRESPONDENCE

A TOPOGRAPHIC MAP OF WISCONSIN

The movement to expedite the completion of the topographic map of the United States by the U. S. Geological Survey, of which some account was given in Science a year ago, is to-day greatly promoted by the increased interest in topographic preparedness on the part of army officers. Doubtless at their instance the sum of $200,000, in addition to the usual large appropriation for topographic maps under the Geological Survey, has lately been voted by Congress to be expended for geodetic and topographic surveys at the discretion of the Secretary of War. Members of the Coast and Geodetic Survey and of the Geological Survey have already taken the field, chiefly in the Southern States, in areas designated by the war department, and a much desired increase in topographic output will be the result. It is interesting to note in this connection that, although the additional sum thus appropriated is spent under military direction, the work for which the sum is spent is performed by the experts of the two civilian surveys, who are all listed in the reserve corps.

In the meantime the civil uses of topographic maps must not be forgotten, and among these the educational uses are by no means the least important. An excellent statement of them follows with respect to the needs of a single state in a letter by Professor Lawrence Martin, of the University of Wisconsin, to the state engineer at Madison. Educators and engineers elsewhere would do well to organize a similar movement for promoting the topographic survey of their states also.

W. M. Davis

LETTER, DATED MAY, 1917, FROM PROFESSOR LAWRENCE MARTIN, OF THE UNIVERSITY OF WISCONSIN, TO THE STATE ENGINEER AT MADISON

My Dear Sir: In support of the proposed state appropriation for topographic maps I am writing to explain the need of these maps for educational purposes. This is only one of the many uses for which I regard these maps as desirable, but it is the one to which I am giving especial attention as a member of our committee.

Topographic maps are an admitted need for school and college use, as explained later. Let us compare Wisconsin with Ohio, states not dissimilar in area, topography and educational system. We are proposing to ask the legislature for $20,000 a year for twenty years to complete the topographic map of Wisconsin in the next two decades. Twenty years ago there was not a single topographic map of any part of Ohio. Mapping was started nineteen years ago, and to-day the topographic maps cover the entire state. Every college, normal school, high school, grade school and other educational institution in Ohio has a topographic map of the home area for use by its students.

Twenty years ago Wisconsin had twenty-seven topographic maps. In these two decades we have added seventeen maps, while Ohio has added more than two hundred.

The states of Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland and West Virginia are completely mapped. More than half of Kansas, Oklahoma, Utah, Arizona, California, Vermont, Virginia, Colorado, Tennessee and Pennsylvania are covered by topographic sheets. Only about a fifth of Wisconsin is mapped.

There are 413,000 school children in Wisconsin who live outside the area covered by topographic maps. Five of our nine normal schools have no topographic maps of their home area. Twenty-two of the county training schools for teachers and the county schools of agriculture are outside the mapped area. For fourteen of the cities which maintain continuation schools there are no maps. There is no topographic map covering the area about the Stout Institute at Menomonie. There are none for the colleges at Appleton (Lawrence University), at Plymouth (Mission House College), at Ashland (Northland College), at Beaver Dam (Wayland Academy), or for a number of the Catholic colleges and some of the private schools. There are no maps for the Indian schools near

Tomah, at Hayward, and on the other reservations (Carter School, etc.). Beside these there are many large high schools which need maps, some of them at places listed above, others at various cities.

Of course topographic maps are quite as important for the smaller cities and villages and for the country schools as for the places listed above. Wisconsin ought not to lag behind Ohio, New York, West Virginia, or any other state, or behind England, France, Germany, or Italy, all of which are completely mapped, in providing topographic maps for educational use.

In addition to the very necessary local use of topographic maps of the home area, it is desirable that students in one region should use the maps of other parts of the state. Pupils in the Milwaukee, Racine, Madison, Superior, and other high schools ought to have a chance to study topographic maps of the vicinity of La Crosse, Eau Claire or Ashland, where there are no maps as yet. Students in the country schools need them even more. College students at Beloit, Ripon, Milton, Carroll, Watertown, Marquette and Milwaukee-Downer, and normal-school students at Platteville, Whitewater, Milwaukee and Superior, where there are topographic maps, need maps of the other four fifths of Wisconsin where there are none.

At the University of Wisconsin we need not only the completed topographic sheets of the adjacent country, which our students now use extensively in laboratory work and field study, but maps of all other parts of the state, for our students come from everywhere in the state, they go back to all parts of the state to work or to teach, and we can not adequately study other parts of Wisconsin without maps of these decidedly different areas. The same thing applies to the other colleges, to all the normal schools, the large high schools, the country schools and the educational system generally. The State Geological Survey is considering a plan of publishing and distributing lists of topographic maps for schools of varied size and situation, with simple, comprehensive directions for their use in classes; this can not be done effectually until much more of Wisconsin is covered by topographic maps.

Very truly yours,

LAWRENCE MARTIN

WINTER ACTIVITY OF THE BROWN BAT, VESPERTILIO FUSCUS (BEAUVOIS), AT BROOKLYN, N. Y.

THE sporadic appearance of *Vespertilio fuscus* on mild winter evenings, in the latitude of New York, is a well-known phenomenon,[1] but the following account describes altogether extraordinary behavior on the part of a bat of this species.

A few minutes after five o'clock P.M., on February 14, 1917, Mr. George P. Engelhardt, of the Brooklyn Museum, and the writer entered the Brooklyn Botanic Garden with the purpose of finding a mocking-bird that had been observed to be wintering in the section of the grounds devoted to a Japanese garden. While we were hunting through a copse of evergreens bordering the small frozen lake, we were astonished to see a bat flying above the ice. The creature made several trips back and forth, over a distance of seventy or eighty yards, passing so close to us that we had no difficulty in recognizing the species. It circled about just as though it were pursuing insects over the water on a summer evening, except that its flight was slow and obviously labored, and we expected to see it drop at any moment. Presently it fluttered westward, beyond the end of the lake, and seemed to descend on a grassy meadow. We hastened in that direction, searching the ground, but, as we saw no more of the bat, Mr. Engelhardt left the Garden.

I then walked to the Botanical Laboratory in order to note the temperature, which was 30° F. The afternoon had been cloudy, and the setting sun shone only as a red ball through the calm, chilly, misty air. It is worth remarking that the first slight thaw after a protracted period of severely cold weather had occurred on this date. On the morning of the previous day, February 13, the thermometer had registered +3° F., in this part of Brooklyn.

Returning to the edge of the lake at 5:25 P.M., I saw the bat again, and ran after it, but soon lost sight of it. Then, as I approached the outlet of the lake, I spied it on a sheet of thin ice almost surounded by the running water of the brook, three feet above a small waterfall. While I stood quietly within ten feet of it, the bat crawled rapidly about the ice, lapping it with its tongue. Next it

[1] Murphy and Nichols, *Sci. Bull. Brooklyn Inst. Mus.*, Vol II., No. 1, 1913, p. 7.

moved towards the margin, paused an instant, then deliberately plunged into the water. It swam strongly across the current, keeping its head, wrists, widely spread feet, and the tip of its tail above the surface, and making sculling strokes with its phalangeal membranes, which hung straight downward. The greater part of its back, and its interfemoral skin, except near the tip of the tail, were submerged. After reaching the ice a yard across the open stream, it turned and swam back, and attempted to clamber out at the point where it had entered. Like King Robert Bruce's spider, it made six vain trials but on the seventh it succeeded. It then shook itself in quadrupedal fashion, crawled across the ice to a nook beneath an overhanging rock, and lay still. I continued to watch it for five minutes, and was tempted to leave it until morning; but, realizing that it would soon be frozen to the spot, I picked it up.

In my hand it seemed perfectly active, at first struggling and biting characteristically, and giving vent to infinitesimal squeaks and to explosive puffs like the sound of a tiny one-cylinder engine. At times it would shake its head with a rapid vibration and snort loudly. Within a few moments it began to lick its membranes, comb its snout, ears and body with its long-clawed feet, then to clean the claws with its teeth, and, in short, to go through all the elaborate preening movements which make bats so extremely kitten-like. From time to time I noticed an evanescent, skunkish odor, which seemed as though it might be due to some periodical, perhaps defensive, glandular exudation. Its wet fur dried surprisingly quickly under the influences of the violent combing, and the high temperature that the animal soon developed by means of respirations at the rate of about 145 per minute.

The bat was an old female, with teeth worn down to a condition similar to that already described by Murphy and Nichols (*l. c.*, p. 8). Although it could have eaten no food for three months or more, it passed feces which proved to be composed principally of its own fur.

Probably the most noteworthy point about the whole incident is the record of an unwounded bat, certainly in full control of its bodily coordination, swimming in the icy water of a stream, apparently with intent.

Robert Cushman Murphy
Department of Natural Science,
Brooklyn Museum

DR. HOBBS ON THE HISTORY OF SCIENCE

To the Editor of Science: Touching the address of Professor William H. Hobbs to the Michigan Academy of Science, printed in Science (issue of May 11, 1917), I wish to point out:

1. That it is not customary among historians and students of history to consider the thousand years following the Hun invasions the "dark ages," or, as Professor Hobbs calls them, a "thousand years of stagnation" (p. 443) or "centuries of intellectual stagnation" (p. 442). No period which includes the thirteenth century can fairly be so described.

2. That Galileo never was tortured by the Inquisition (p. 443) and that the only "imprisonment" he suffered was in the homes of his friends.

3. That Giordano Bruno was burned for denying the divinity of Christ—not for advocating the Copernican doctrine.

4. That what Mr. Huxley termed "that chaff about the ego and the non-ego, about noumena and phenomena and all the rest of it, etc.," are not *mere* "metaphysical abstractions" in the sense that any thinking man can dispense with them. A thorough grounding in metaphysics (and logic) would be a very good start for a career in "science"; one does not know either intuitively and both are necessary for clear thinking and sound generalizing.

Thomas F. Woodlock
Mount Vernon, N. Y.

SCIENTIFIC BOOKS

Manual of Psychiatry. Fourth edition. Revised and enlarged. By J. Rouges De Fursac, M.D., and A. J. Rosanoff, M.D. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited. 1916. 8vo. Pp. 522.

Brevity, clearness of diction and simplicity of presentation with a sufficiently small num-

ber of points of discussion—these are the points which make a popular text for students. De Fursac and Rosanoff's book has gained a well-deserved place with medical students through these qualifications, and it will deserve it even more fully in the present form. Up to the present edition the text kept apart the translation and the translator's annotations. This distinction has been obliterated and in reality the book has been adapted much more definitely to the needs of the American student, at least in the chapters entitled "The Practise of Psychiatry," which give a helpful picture of the present-day dispensary and state hospital practise.

The book represents a somewhat extraordinary combination in view of the fact that it is primarily an adaptation of the German psychiatry to a French public and then a re-adaptation to the American viewpoints. French psychiatry has in the meantime shown some evidences of revolt and repudiation, and American psychiatry, if we can speak in such a summary way, shows signs of a considerable degree of emancipation. For the purposes of the student, however, it is most important that he get some reasonably clarified starting point, and with the qualifications of the original description by Rosanoff, the transition is made reasonably easy and will no doubt offer a good basis for further emancipation as further editions will demand it. It may be possible to eliminate some unnecessary evidences of translation such as the reference on page 21 to Jean Muller, whom probably most of us know as Johannes Mueller.

"In the first part of the book, the chapters dealing with etiology, history taking, methods of examination, special diagnostic procedures, general prognosis, prevalence of mental disorders, prevention, and medico-legal questions, and, in the second part, those dealing with Huntington's chorea, cerebral syphilis, and traumatic psychoses are either wholly new or almost so.

"The chapter on general therapeutic indications, in the first part of the book, and those on dementia præcox, chronic alcoholism, general paresis, and mental disorders due to organic cerebral affections, in the second part, have been more or less extensively revised or added to."

Rosanoff's standpoint with regard to heredity is very strongly emphasized in the book to the effect that he feels that "we are in a position to say to the people and to legislatures: Mental health is purchasable; the prevalence of mental disorders can be reduced for coming generations with the aid of dollars and cents spent for segregation in this generation."

For the problems of non-institutional care it might be wrong to expect too much help from a book. The problem of psychotherapy is treated rather briefly, but is one of those things that have to be learned from practise and with the help of special literature.

ADOLF MEYER

THE JOHNS HOPKINS UNIVERSITY

SPECIAL ARTICLES

A SUGGESTION REGARDING THE MECHANISM OF ONE-SIDED PERMEABILITY IN LIVING TISSUES[1]

IT is a familiar fact to physiologists that a large proportion of living tissues display a type of permeability markedly differing from the permeability or semipermeability of the majority of non-living membranes in that it is dependent upon direction, that is, upon the side of the membrane exposed to the dissolved substance. Among the almost numberless illustrations of this phenomenon which might be adduced it will be sufficient to cite the experiment of Cohnheim[2] in which a glucose solution, free from sodium chloride was introduced into an isolated loop of intestine. After the lapse of a certain period investigation of the residual fluid showed that while some fifty per cent. of the water and glucose had passed through the wall of the intestine into the blood stream, only an insignificant trace of sodium chloride had passed from the blood stream into the glucose solution. This is not the

[1] From the department of biochemistry, Rudolph Spreckels Physiological Laboratory, University of California.

[2] O. Cohnheim, *Zeitschrift f. Biologie*, 36 (1898), p. 129.

case if the glucose solution be placed in the peritoneal cavity instead of in the intestine. In this case the peritoneal wall behaves like a membrane of parchment. Not only water, but also dissolved substances traverse the membrane in both directions with equal facility, so that after a certain lapse of time the residual glucose solution is found not only to have parted with glucose, but also to have gained from the tissue fluids a very appreciable proportion of sodium chloride.

The phenomenon of one-sided permeability is perhaps nowhere more strikingly illustrated than in the tissues of the kidney which pick out urea from the blood, although present therein in minute concentration, and secrete it into the secretory tubules of the kidney against a relatively enormous osmotic pressure. The epithelium of the kidney is evidently permeable to urea in the direction blood → urine, but under normal conditions must be impermeable or very nearly impermeable to urea in the direction urine → blood. That the one-sided permeability of the kidney is dependent upon the maintenance of the normal structure of the renal epithelium is revealed by its failure in pathological conditions involving partial destruction of the renal epithelium and also by the striking experiment of Bottazzi[3] in which he compared the excretion of the right and left kidneys of the same animal after injury of one of them by sodium fluoride; for while the uninjured kidney secreted urine which was markedly hypertonic in comparison with the blood, the injured kidney secreted urine which was actually hypotonic in comparison with the blood.

It is obvious that the phenomenon of one-sided permeability must be dependent upon a heterogeneous structure of the membrane which displays it. The phenomenon is not and could not be displayed by structureless membranes or by membranes having a uniform structure in the direction of penetration, *i. e.*, perpendicularly to their surface. Nor would any structure of macroscopic dimensions, *i. e.*, involving structural elements of a size far in excess of the mean free path of the molecules, suffice to endow the membranes with this peculiar property. We must therefore seek for the interpretation of the phenomenon in the minute structure of the cell.

A specific arrangement of permeable and relatively impermeable phases of the cell-substance would appear to offer the only reasonable basis for interpretation of the phenomenon. In seeking for constituents of protoplasm which are impermeable or but slightly permeable to the majority of substances dissolved in water the lipoids immediately present themselves as the constituents of the cell most markedly differing from the remainder of the protoplasm in their solubilities and solvent power.

That lipoids are present in abundance in living cells either in combinations of such a character as to mask their micro-chemical properties or in particles so small as to be of very nearly ultramicroscopic dimensions is very strikingly shown by the investigations of Athanasiu,[4] Taylor[5] and others who have shown that the tissues of the liver and other organs in the fatty degeneration induced by phosphorus poisoning do not necessarily contain more and indeed may contain slightly less fat than the corresponding normal tissues. In other words, the fat which is present in the tissues of phosphorized animals in the form of microscopically visible aggregates, is present in the corresponding normal tissues in aggregates too small to be identifiable by staining reactions. The same inference may be drawn from the observation of Gay and Southard[6] that in animals which have experienced anaphylactic shock the gastric epithelium is loaded with visible fat globules, whereas normal gastric epithelium is free from visible fat. In the brief period which elapses between the administration of the foreign protein and death in anaphylactic shock there is no time for transmissal of fat from

[3] Bottazzi, F., *Archivio di Fisiologia*, 1 (1904), p. 273.

[4] Athanasiu, J., *Arch. f. d. ges. physiol.*, 74 (1899), p. 511.

[5] Taylor, A. E., *Jour. of Exper. Med.*, 4 (1899), p. 399.

[6] Gay, F. P., and Southard, E. E., *Jour. of Med. Research*, 16 (1907), p. 143.

one tissue of the body to another. We must assume that the fat in the gastric epithelial cells is present in normal animals in ultramicroscopic or very nearly ultramicroscopic aggregates, and that the circumstances attendant upon anaphylactic shock have merely induced coalescence of the preexisting fat granules into aggregates sufficiently large to be identifiable as fat.

The existence of a considerable proportion of ultramicroscopic fat-granules in living cells which is thus established provides a material basis for the assumption of a diphasic structure in which the one phase is permeable and the other impermeable to substances soluble in water but insoluble or relatively insoluble in fats.

The most usual spatial arrangement of the various structures or constituents of a cell is that of radial symmetry. The primitive arrangement of strictly radial symmetry so frequently displayed in spherical cells becomes modified or distorted in those cells, such as the majority of epithelial cells, which through mutual compression, or for other reasons, have assumed a columnar, stratified or flattened outline. In such cases the radial arrangement of structures may be confined to the sides or margins of the cell or differ in character in the protoplasm underlying the various facets of the cell.

A radial arrangement of the ultramicroscopic fat granules of the cell would obviously lead to the formation upon the surface and in the subjacent protoplasm of minute funnel-shaped pores, of which the interstitial openings would be permeable to substances soluble in water, while the walls, being composed of fat granules, would be impermeable or with difficulty permeable by such substances. The interstitial openings at the margin distal from the center from which the fat granules radiate would be relatively large, while at points lying nearer to the center of radiation, that is, in general, deeper within the cell, even if the radiating lines of globules should not be continued sufficiently far in that direction to actually intersect one another, the diameter of the pores would be very considerably contracted. Substances soluble in water would penetrate such a cell readily, since a relatively large proportion of the cell-surface would consist of the water phase, but they would leave the interior of the cell with difficulty, since a relatively large proportion of the area which they would have to traverse to attain an outlet would consist of the lipoid phase. If the modifications of radial symmetry which are so characteristic of epithelial cells should result in the confinement of this structure to one surface or facet of the cell it is obviously possible that one-sided permeability of a tissue composed of such cells might be the consequence.

It should be borne in mind that the existence of funnel-shaped pores in the surface of a cell or membrane would only give rise to one-sided permeability provided the diameter of the pore at the constricted end were comparable with the mean free path of the penetrating molecules. Were the least diameter of the pores less than the mean free path of a given molecule, then the membrane would be a strictly semipermeable one for this type of molecule; were it, on the contrary, very large in comparison with the mean free path of the molecule concerned, then the membrane would be freely permeable by the molecule in either direction. Thus it is readily conceivable that membranes of this type might exhibit one-sided permeability for certain substances dissolved in water, absolute permeability for others, and semipermeability for yet other molecules.

Any reagent or condition affecting the state of aggregation of the fat globules would necessarily affect the diameter of the pores. In general those conditions involving the formation of large aggregates would increase the permeability of tissue by enlarging the diameter of the radiating droplets and therefore that of the interstitial spaces. Moreover, since the droplets are suspended in a protoplasmic gel, we may infer that in all probability their radial dispersal would be modifiable by alterations of the state of aggregation of the proteins of the cell. The relationship of lipoid solubility and of lipoid solvents and of substances which have a marked effect upon surface tension to the permeability of cells thus find an

intelligible explanation. In the light of the investigations of Clowes[7] and of Fenn[8] upon the influence of inorganic salts upon the state of aggregation of oil emulsions and of proteins in solution it would appear not at all improbable that the striking phenomena of salt-antagonism which Osterhout has shown to depend upon the preservation of minimal cell-permeability, owe their origin to antagonistic alterations of the state of aggregation or displacements of the radial distribution of the lipoid granules of the cell, resulting, when either of the mutually antagonistic salts is present in excess, in enlargement of the interstitial pores.

T. Brailsford Robertson
University of California

THE UTAH ACADEMY OF SCIENCES

The tenth annual convention of the Utah Academy of Sciences was held at Salt Lake City, April 6 and 7, 1917, in the Young Memorial Building.

Four sessions were held beginning as follows: Friday, April 6, at 2 P.M. and again at eight P.M., Saturday, April 7 at 10 A.M. and the closing session at 2 P.M.

President Frank S. Harris occupied the chair at all the sessions.

Dr. Geo. R. Hill, Jr., of the Utah Agricultural College, Dr. Perry G. Snow and Dr. Newton Miller, of the University of Utah, and C. Arthur Smith, of the East High School, Salt Lake City, were elected fellows.

The following were elected to membership: Dr. Orin Tugman, U. U., Professor Walter A. Kerr, U. U., Dr. Frederick S. Pack, U. U., Dr. Joseph F. Merrill, U. U., Professor Elbert D. Thomas, U. U., Mr. James S. Godfrey, U. U., Mr. John W. Sugden, U. U., Dr. Walter D. Bonner, U. U., Professor Hyrum Schneider, U. U., Professor Geo. Coray, U. U., Professor Sherwin Maeser, B. Y. U., Provo, Clarence F. Korstian, Forest Service, Ogden, H. J. Frederick, U. A. C., Professor Clarence J. Sorensen, U. A. C., Logan, Mr. Sidney B. Sperry, Salt Lake City, Mr. L. A. Giddings, East High School, Salt Lake City, Mr. L. Moth Iverson, Salt Lake City, Mr. James W. Jones, Salt Lake City and Mr. Tom Spalding, Provo.

The following are the officers for the ensuing year:

President—W. D. Neal, Salt Lake City.

First Vice-president—Dr. L. L. Daines, U. U., Salt Lake City.

Second Vice-president—Dr. W. E. Carroll, U. A. C., Logan.

Permanent Secretary—A. O. Garrett, East High School, Salt Lake City.

Assistant Secretary—C. Arthur Smith, East High School, Salt Lake City.

Councilors—Dr. Newton Miller, U. U., Salt Lake City; C. Arthur Smith, East High School, Salt Lake City, and Professor Carl Eyring, B. Y. U., Provo.

The following papers and lectures were presented:

"The Pressure-watt Characteristics of Drawn Wire Tungsten Lamps," by C. Arthur Smith, East High School, Salt Lake City.

"The Variation of the Electric Conductivity of Thin Metal Films," by Dr. Orin Tugman, U. U., Salt Lake City.

"The Anastomosing of Arteries and Veins in a Family of Cats," by Dr. Newton Miller and Mr. James Godfrey, U. U. (Paper presented by Mr. Godfrey.)

"Preformation in Modern Science," by Dr. Newton Miller.

"The World without Science" (presidential address), by Dr. Frank S. Harris, U. A. C.

"The Value of Scientific Research in Forestry," by Mr. Clarence F. Korstian, Forest Service, Ogden.

"Comparative Essay on some Birds of Europe and North America," by L. Moth Iverson, Salt Lake City.

"The Effectiveness of the Corrosive Sublimate Treatment of Potatoes," by Mr. Bert L. Richards and Dr. Geo. R. Hill, Jr., U. A. C. (Paper presented by Dr. Hill.)

"Factors affecting the Planting of Various Crops," by Howard J. Maughan, U. A. C.

"Freezing Temperatures in Fruit Buds," by Dr. Frank L. West, U. A. C.

"Sugar Beet Syrup for Young Pigs," by Dr. W. E. Carroll, U. A. C.

"The Present Situation of Rabies in the State," by Dr. L. L. Daines, U. U.

"The Time Element in Voluntary Control," by Dr. Geo. S. Snoddy, U. U.

"The Liquid Sulfur-dioxid Method of determining Aromatic Hydrocarbon Oils," by Mr. Joseph, U. U.

"The Destructive Distillation of Gilsonite," by Mr. Erickson, U. U.

A. O. Garrett,
Permanent Secretary

[7] Clowes, G. H. A., *Journal of Physical Chemistry*, 20 (1916), p. 407.

[8] Fenn., W. O., *Proc. Nat. Acad. of Sciences*, Washington, 2 (1916), pp. 534 and 539.